470

HICKOK

INSTRUCTION BOOK

ELECTRONIC VOLT-OHM METER

MODEL 470

THE HICKOK ELECTRICAL INSTRUMENT COMPANY · 10514 Dupont Avenue, Cleveland 8, Ohio

INSTRUCTION BOOK

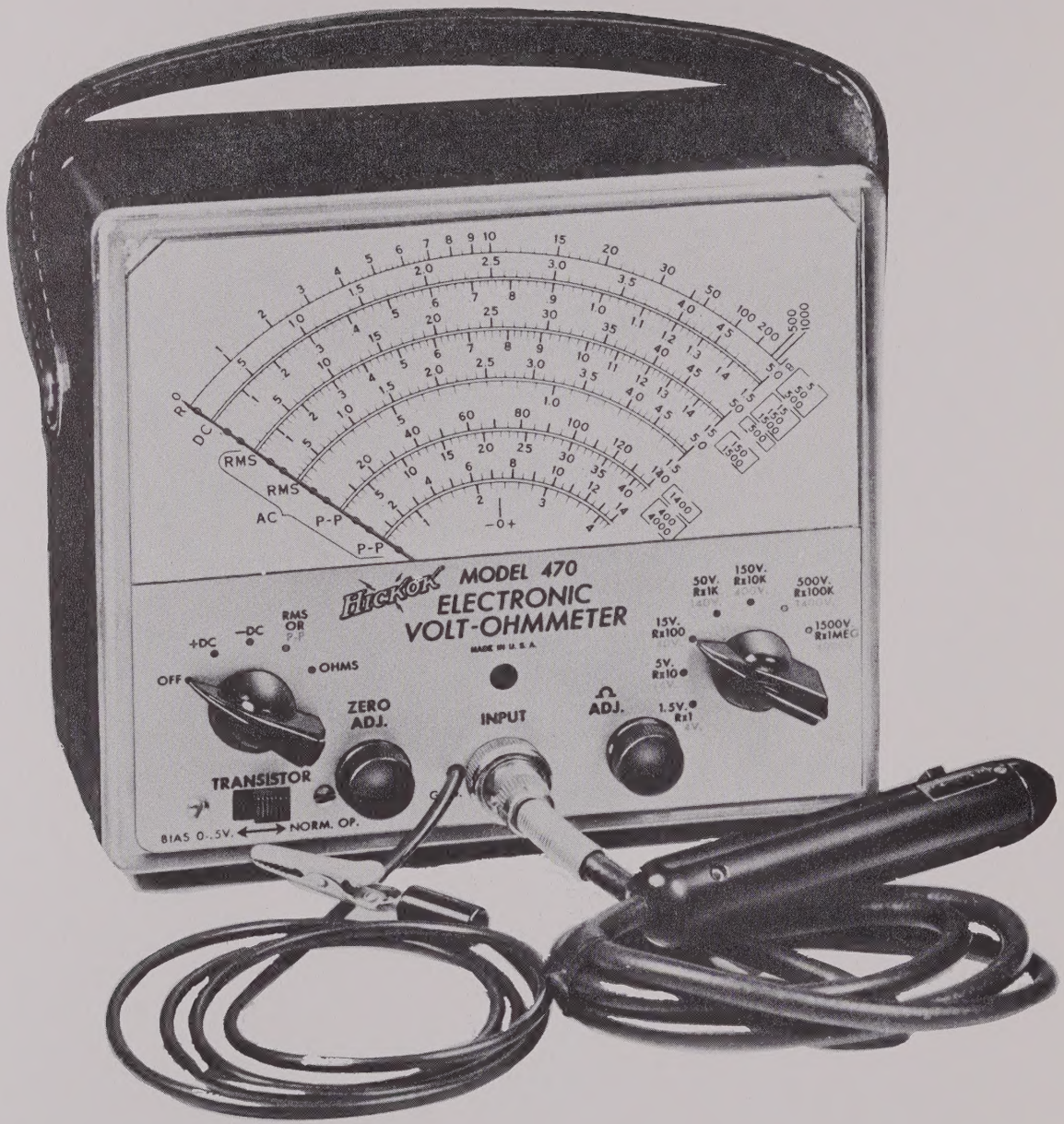
FOR

ELECTRONIC VOLT-OHM METER

MODEL 470

Litho in U.S.A.

2490-322



ELECTRONIC VOLT-OHM METER

MODEL 470

STANDARD EIA GUARANTEE

The Hickok Electrical Instrument Company warrants instruments manufactured by it to be free from defective material or factory workmanship and agrees to repair such instruments which, under normal use and service, disclose the defect to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any instrument or test equipment which proves to be defective, when returned to us transportation prepaid, within 90 days from the date of original purchase, and provided the serial number has been made known to us promptly for our records.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons or service stations in any way so as, in our judgment, to injure their stability or reliability, or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced or removed. Neither does this warranty apply to any of our products which have been connected, installed, or adjusted otherwise than in accordance with the instructions furnished by us. Accessories, including all vacuum tubes not of our manufacture, used with this product are not covered by this warranty.

This warranty is in lieu of all other warranties expressed or implied, and no representative or person is authorized to assume for us any other liability in connection with the sale of our products.

Parts will be made available for a minimum period of five years after the manufacture of this equipment has been discontinued. Parts include all materials, charts, instructions, diagrams, accessories, etc., which have been furnished in the standard model.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Upon authorization, this equipment should be forwarded directly to the Hickok factory address, 10636 Leuer Avenue, Cleveland, Ohio, or to a designated service station in your locality. All correspondence pertaining to repairs should be directed to the Hickok office address, 10514 Dupont Avenue, Cleveland 8, Ohio, or to the authorized service station designated.

REGISTRATION CARD

The above guarantee is contingent upon the attached registration card being returned to the factory immediately upon receipt of the equipment.

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
Cleveland, Ohio

TECHNICAL DATA SHEET

Equipment Supplied
(One complete unit)

Quan.	Name	Stock No.	Dimensions
1	Electronic Volt-Ohmmeter	220-170	
1	Instruction Book	2490-322	8-1/2 x 11"
1	Probe Assy	16970-36	48"

TECHNICAL CHARACTERISTICS

1. Power Supply Required: 105-125 V, 50-1200 cycles, AC.

2. Power Consumption: 15 watts at 115 volts.

3. Scales:
   a. Volts DC - RMS: 0 - 1.5, 0 - 5
      ± Zero Center
   b. Volts AC - RMS: 0 - 1.5, 0 - 5, 0 - 15, 0 - 50
      - Peak-to-Peak: 0 - 4, 0 - 8, 0 - 32, 0 - 80
   c. Ohms: 0 - 1000 - Inf.

4. Ranges:
   a. Volts DC: 0 - .5, 1.5, 5, 15, 50, 150, 500, 1500
   b. Volts AC: RMS: 0 - .5, 1.5, 5, 15, 50, 150, 500, 1500
      Peak-to-Peak: 0 - 4, 14, 40, 140, 400, 1400, 14,000
   c. Ohms: 0.2 ohm to 1000 megohms in 7 ranges

5. Frequency: AC RMS or Peak-to-Peak up to approximately 3 mc.

6. Input Impedance:
   a. Volts DC: 10.5 megohms
   b. Volts AC: 3 megohms shunted by 150 $\mu\mu$f.

7. Meter: Model S66, Style 660-
   Sensitivity: 100 microamperes

8. Tube Complement:

Quan.	Tube	Stock No.	Function
1	5963	20875-	Vacuum tube voltmeter
1	6AL5	20875-51	AC Input Rectifier

INSTRUCTION BOOK
for
ELECTRONIC VOLT-OHM METER
MODEL 470

I. DESCRIPTION

1.1 Purpose

The Hickok Electronic Volt-Ohmmeter, Model 470, shown in Fig. 1.1 is a compact universal test instrument which may be used in making measurements in the study of radio and electrical circuits. It is a versatile instrument for use in connection with wide ranges of AC and DC voltages and resistance. Built under Hickok high standards of workmanship, it is an accurate durable test instrument.

1.2 Description

a. Physical. The instrument is enclosed in a phenolic case with a leather carrying strap at the top. The chassis is mounted in the case and is accessible by removing the 6 screws holding the back cover of the case. To dis-assemble the chassis completely from the case, remove the 4 spacers located in each corner of the case. The meter is accurately calibrated and the scales clearly marked. Mechanical adjustment of zero setting is provided on the front of the meter.

A special "INPUT" cable probe assembly together with a black common lead is supplied for voltage and resistance measurements. The common lead is permanently attached to the instrument.

b. Function. The Model 470 is designed to perform the following electrical functions:

1. To measure a wide range of AC and DC voltages and resistance.

2. To have a very light loading effect on the circuit under test, thereby insuring greater accuracy.

3. To have a meter circuit designed which will minimize the possibilities of damage to the meter due to overload.

4. Transistor Bias Test. The Model 470 incorporates a special high sensitivity DC volts range activated by a slide switch on the front panel. With the Model 470 range switch turned to 1.5V and the Function Selector Switch on DC volts (+ or -) the transistor switch changes the sensitivity to .5 volts DC.

Due to the high impedance of the Model 470 and the inherent low impedance of transistors, it is recommended that the

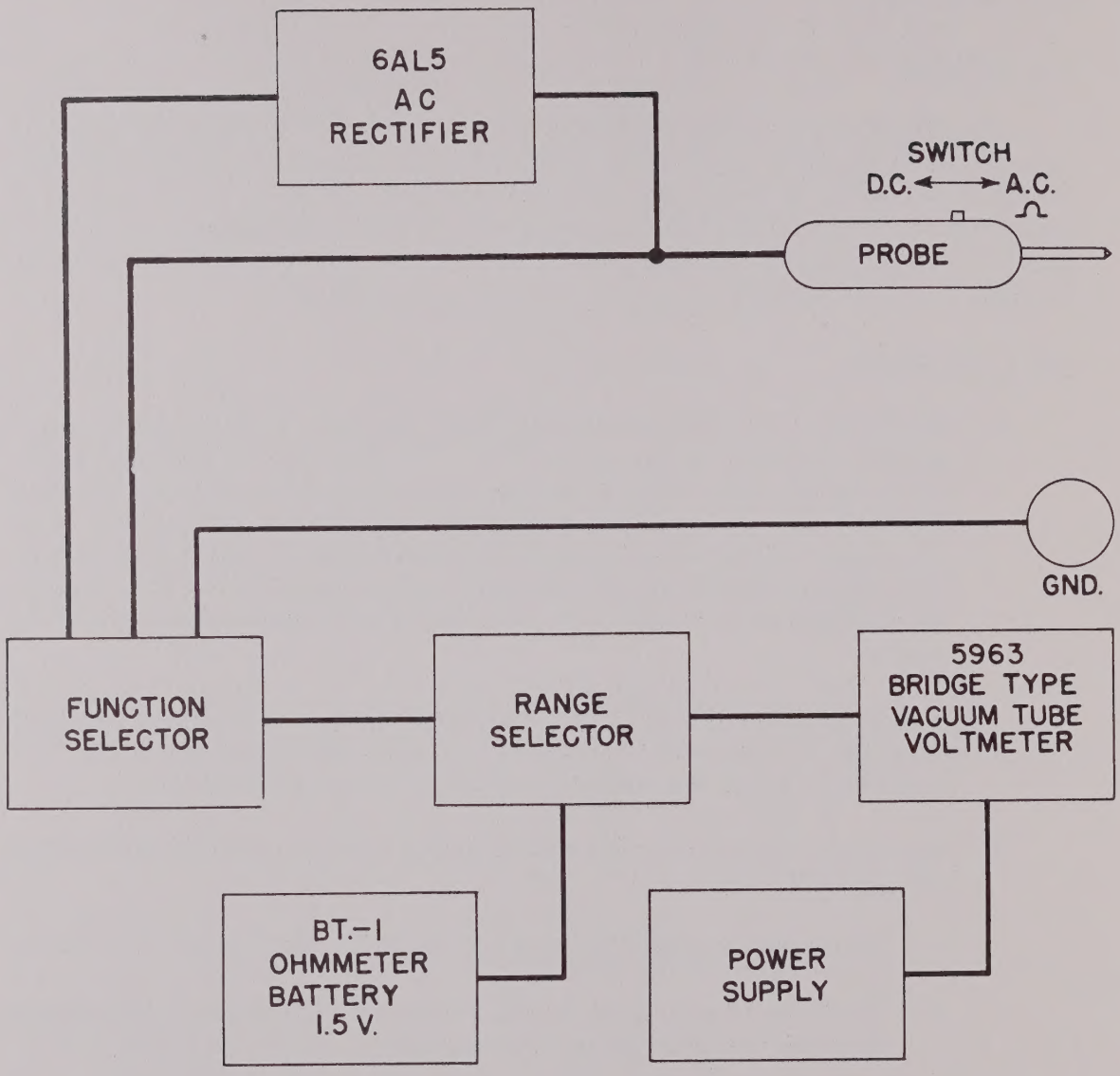


FIG. 2 — BASIC CIRCUITS, BLOCK DIAGRAM.

"Zero" Adjustment of the Model 470 be made with the "Input" Probe shunted to "Gnd".

c. Electrical. A 105 to 125 volt, 50 to 1000 cycles AC external power source is required for the operation of the power supply system which has been incorporated in the unit to supply all DC plate voltages and AC heater voltages. The power supply circuit is of the conventional type consisting of transformers, rectifiers, and filters. A self-contained dry cell supplies the necessary DC voltage for making ohms measurements.

II. GENERAL

2.1 General

A thorough understanding of the theory behind the operation of any instrument will enable the user to obtain greater utility and satisfaction from the instrument. For this reason, the following brief explanation of the circuit of this instrument is given.

2.2 Bridge Circuit

a. The bridge circuit is common to all measuring circuits. Specific application of the bridge is given in the explanation of the type of measurement to be performed, i.e., resistance or voltage.

b. The basic circuit of the bridge is similar to the common Wheatstone bridge in operation. Voltage is applied across the bridge; B+ at P2. P2 acts as a zero adjustment and is adjusted so that with no voltage input to either grid of the tube, the meter reads zero, indicating balance between the two triodes of the twin triode used as the bridge tube. When making all measurements the grid of one triode remains at ground potential and the grid of the other triode changes to a potential determined basically by the unknown being measured. Changing the potential of only one of the grids will unbalance the bridge and cause a deflection of the meter in direct proportion to the change in grid potential, as the plate current changes with grid potential. The meter has a calibrated scale which interprets this deflection in terms of volts or ohms so that, in conjunction with the RANGE switch, the unknown can be evaluated directly from the scale reading. This is basically the action of the bridge and meter. The type of measurement to be made will determine both the input grid to be used and the method of obtaining the input voltage.

2.3 AC Voltmeter.

The AC voltage to be measured is picked up by the probe with the slide switch in the "AC-OHM" position, and rectified by a type 6AL5 tube connected as a voltage doubling circuit so that the measured voltage will be

proportional to the peak-to-peak value of the AC voltage applied. After rectification, this DC voltage is attenuated and applied to the bridge vacuum tube voltmeter circuit. The instrument is then accurately calibrated to indicate the rms and peak-to-peak value of the AC voltage being measured.

2.4 DC Voltmeter.

With the input probe slide switch in "DC" position and the function selector switch on DC + or -, the meter pointer should indicate zero. The DC volts being measured is attenuated and applied to the grid of VT2 and therefore will cause the meter pointer to deflect thus indicating the magnitude of the voltage being measured. With the Function Selector switch on +DC volts and zero volts applied, advancing the Zero Adjust Control will bring the meter to center scale providing a zero center DC Voltage measurement.

2.5 Ohmmeter.

When an unknown resistance is connected across the "INPUT PROBE" and common test lead it is placed in series with a known resistor and a DC voltage incorporated in the instrument. The known resistance is determined by the position of the range selector switch. The voltage applied to the input grid of the bridge tube is the voltage across the unknown resistance caused by the DC current flow. The meter deflection is calibrated in terms of resistance.

2.6 Power Supply.

B+ voltage is obtained by means of a selenium rectifier connected to the secondary winding of the transformer and the resultant voltage is filtered by means of R27 and C6.

III. OPERATION

CAUTION

THE HIGH VOLTAGES WHICH CAN BE MEASURED WITH THIS INSTRUMENT MAY BE DANGEROUS TO LIFE. EXTREME CARE SHOULD BE TAKEN TO AVOID BODILY CONTACT WITH EXPOSED HIGH VOLTAGES.

3.1 General.

a. When making resistance measurements, be sure that the circuitry under test has been de-energized.

b. To avoid errors in resistance measurements be sure that the unknown to be measured is isolated from other circuits. It is sufficient to free only one terminal of the resistor under test.

c. Be sure that the instrument is being operated from the correct external power source. It is necessary to allow a two or three minute warm-up period so that stable operation of the instrument is assured. If the instrument is to be used intermittently over a period of time, it is advisable to keep it turned on to avoid delay.

3.2 AC Voltage Measurements.

a. Operate the Transistor Switch to the "NORM. OP." position.

b. Secure the input probe assembly to the panel connector marked "Input".

c. Operate the slide switch on the probe assembly forward to the "AC-Ohms" position.

d. Operate the function selector switch to the AC voltage position.

e. If the approximate magnitude of the voltage to be tested is known, operate the range selector switch to the range which will give good readability (If the magnitude of the voltage to be measured is unknown set the range selector switch to the highest AC range and when the voltage is actually being tested attenuate this switch to give good readability.)

f. Adjust the zero adjust control until the meter indicates zero voltage.

g. Connect the black test lead to the ground side of the voltage to be measured.

h. Connect the input probe to the other side of the source of voltage and read this voltage on the corresponding scale.

i. If the voltage being measured is on the 1.5 or 5 volt range be sure it is read on the special scales provided for this purpose.

j. RMS or peak-to-peak values of the voltage being measured can be determined by reading the correct scales.

k. AC Frequency characteristics. The input capacity of the AC measuring circuit is approximately 150 $\mu\mu$fd, using the "Input" probe. Voltage measurements of frequencies up to 3 megacycles can be expected to be accurate. If the source impedance of the voltage being measured is relatively low, measurements many times this frequency can also be made. NOTE: IF THE SLIDE SWITCH ON THE PROBE WERE ACCIDENTALLY TURNED ON THE DC POSITION, THE INSTRUMENT WOULD STILL READ VOLTS BUT THE READINGS WOULD BE APPROXIMATELY 10% LOW.

3.3 DC Voltage measurements.

a. Operate the transistor switch to the "NORM. OP." position.

b. Operate the function selector switch to the DC voltage position.

c. Operate the range selector switch to the appropriate position (It is recommended that the range selector switch be set to high range when checking an unknown voltage source and then set this selector switch to lower ranges to obtain good readability on the meter).

d. Adjust the zero adjust control so that the meter indicates zero.

e. Connect the unshielded black test lead to ground on the instrument under test.

f. Operate the slide switch on the probe to the DC position.

g. Connect the tip of the probe to the other side of the DC voltage to be measured and read DC voltage directly from the DC volts scales. NOTE: If the range selector switch is on the 1.5, 15, 150 or 1500 volts position, the black 0-1.5 scale should be used and the readings multiplied by 1, 10, 100, and 1000 respectively. If the 5, 50, or 500 volt range is being used, the black 0-5 scale should be used and the reading multiplied by 1, 10, or 100 respectively.

3.4 Resistance Measurements.

a. Operate the transistor switch to the "NORM. OP." position.

b. Operate the function selector switch to the ohms position.

c. Operate the range selector switch giving consideration to the value of the resistance to be measured.

d. Operate the slide switch on the input probe to the "Ohms-AC" position.

e. Short the ground lead to the input probe and adjust the zero adjust control for zero indication on the ohms scale.

f. Unshort the two test leads and adjust the ohms adjust control for a reading of full scale or infinity on the ohms scale.

g. Connect the test leads across the unknown resistance making sure that it is isolated from any other circuit components which might introduce error.

h. Read the numerical value from the ohms scale directly and apply the proper multiplication factor determined by the position of the range selector switch.

3.5 Transistor Testing.

Generally the DC voltages used in transistorized equipment are relatively low. To provide an accurate means of checking these voltages, your Model 470 incorporates a special high sensitivity DC voltage range (0-.5V). This range is used in the following manner:

a. Operate the slide switch on the probe to the DC position.

b. Operate the transistor slide switch to the "BIAS" position.

c. Operate the Function Selector switch to a DC volts position, and the Range Selector switch to the 1.5 volts position.

Due to the high sensitivity of this range, a slight amount of pick-up may be present, therefore short the input of the probe to the ground lead and by the use of the Zero Adjust Control, adjust the meter to indicate zero. Read the transistor bias voltage on the 0-5 volt range and divide the indicated voltage by 10.

IV MAINTENANCE

4.1 General.

As the Model 470 has been built to the high standards of workmanship of a Hickok instrument, no maintenance other than routine replacement of tubes or battery should be necessary. It is suggested that, should the instrument need maintenance other than routine replacements, the factory be contacted with regard to the nature of the trouble, and if necessary, the instrument be shipped to the factory or an authorized Hickok service station for inspection and service.

Figure 4.1 showing tube location, and Schematic Wiring Diagram, Figure 5.1, are given to aid in maintenance work.

4.2 Vacuum Tubes.

All vacuum tubes are operated at their normal rating to insure long life and uniform service. To gain access to the tubes remove the rear of the case (see Paragraph 1.2).

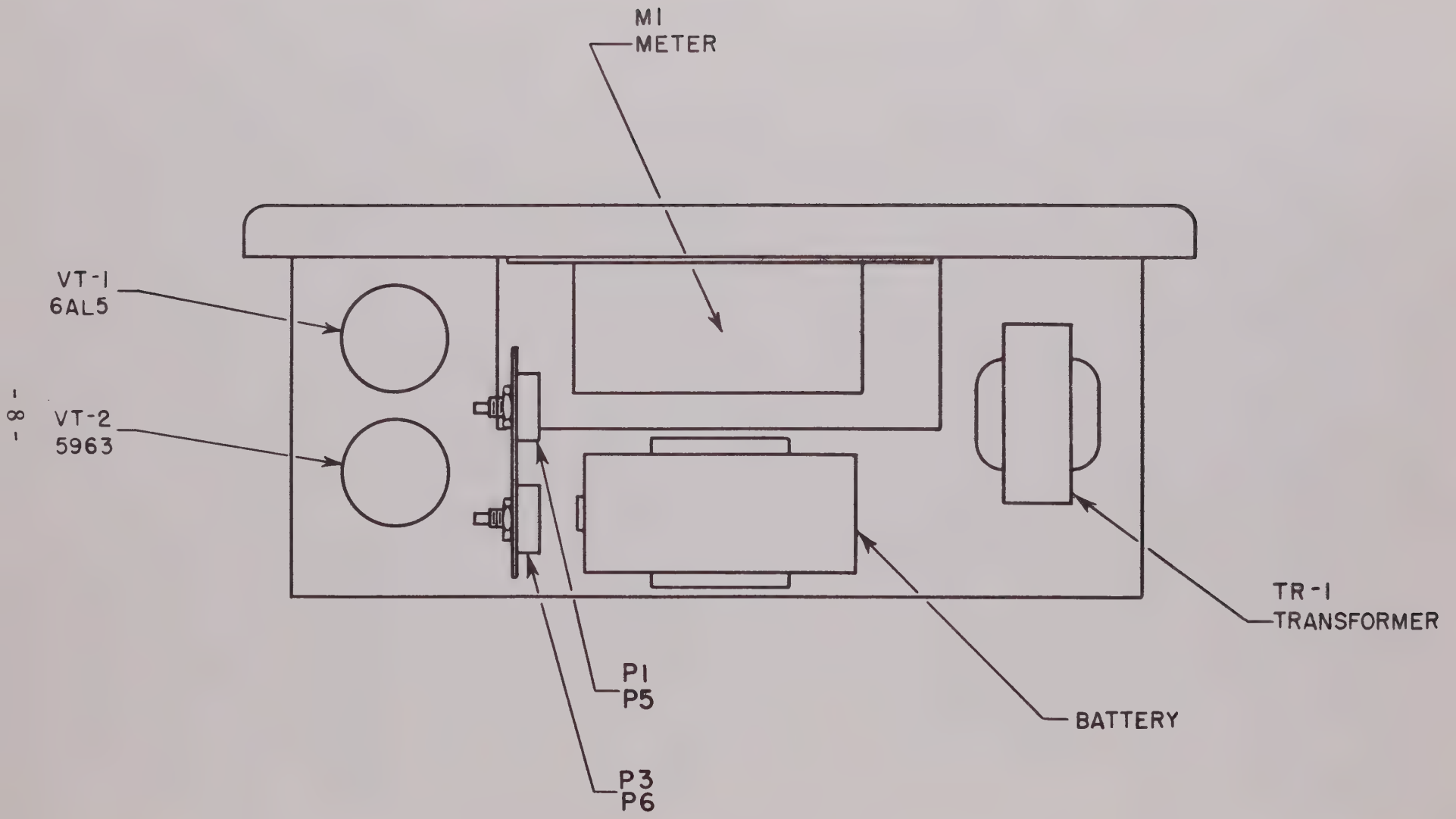


FIG. 3 — TUBE LOCATIONS.

PARTS LIST FOR MODEL 470

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

Hickok Code No.	Name and Description	Symbol Ref.
2490-322	Booklet: Instruction	
3105-175	Capacitor: paper, plastic coated, .05 mfd 400V, Sangamo Type 30	C1
3105-167	Capacitor: paper, .025 mfd 400V, Astron AM or equal	C2, 5
3115-2	Capacitor: trimmer, 6.5-35 mmf, Centralab #820-402	C3
3105-56	Capacitor: paper, .05 mfd, 1000V, Cornell-Dubilier "Grey Tiger"	C4
3085-74	Capacitor: electrolytic, 20 mfd, 250V	C6
220-170	Meter: 100μa, 3000Ω	
16970-36	Probe Assembly: Ohms-AC-DC probe	PR1
40400-103	Potentiometer: 10,000Ω, carbon, linear, 20%, screwdriver slot, Chicago Telephone Type 70	P1, 3, 5
16925-326	Potentiometer: 25,000Ω, carbon, linear, 20% Chicago Telephone Type 70	P2
16925-325	Potentiometer: 50,000Ω, carbon, linear, 20%, Chicago Telephone Type 70	P4
40400-253	Potentiometer: 25,000Ω, carbon, linear, 20% screwdriver slot, Chicago Telephone Type 70	P6
18150-18	Rectifier: selenium, Selection 1Y8, Radio Receptor Co.	CR1
18415-472	Resistor, fixed: composition, 4.7 megohms, 10%, ½ watt, Allen Bradley Type EB	R1
	Resistor, to be determined in production	R2
18539-29	Resistor, fixed: film, 7 megohms, 1%, 1 watt, Electra DC1	R3
18537-112	Resistor, fixed: film, 9.75 ohms, 1%, ½ watt, Electra DC ½A.	R4
18537-45	Resistor, fixed: film, 90 ohms, 1%, ½ watt, Electra DC ½A.	R5
	Resistor, to be determined in production	R6
18537-110	Resistor, fixed: film, 2 megohms, 1%, ½ watt, Electra DC ½A.	R7, 9
18537-4	Resistor, fixed: film, 900Ω, 1%, ½ watt, Electra DC ½A.	R8
18537-50	Resistor, fixed: film, 700,000 Ω, 1%, ½ watt, Electra DC ½A.	R10

PARTS LIST FOR MODEL 470

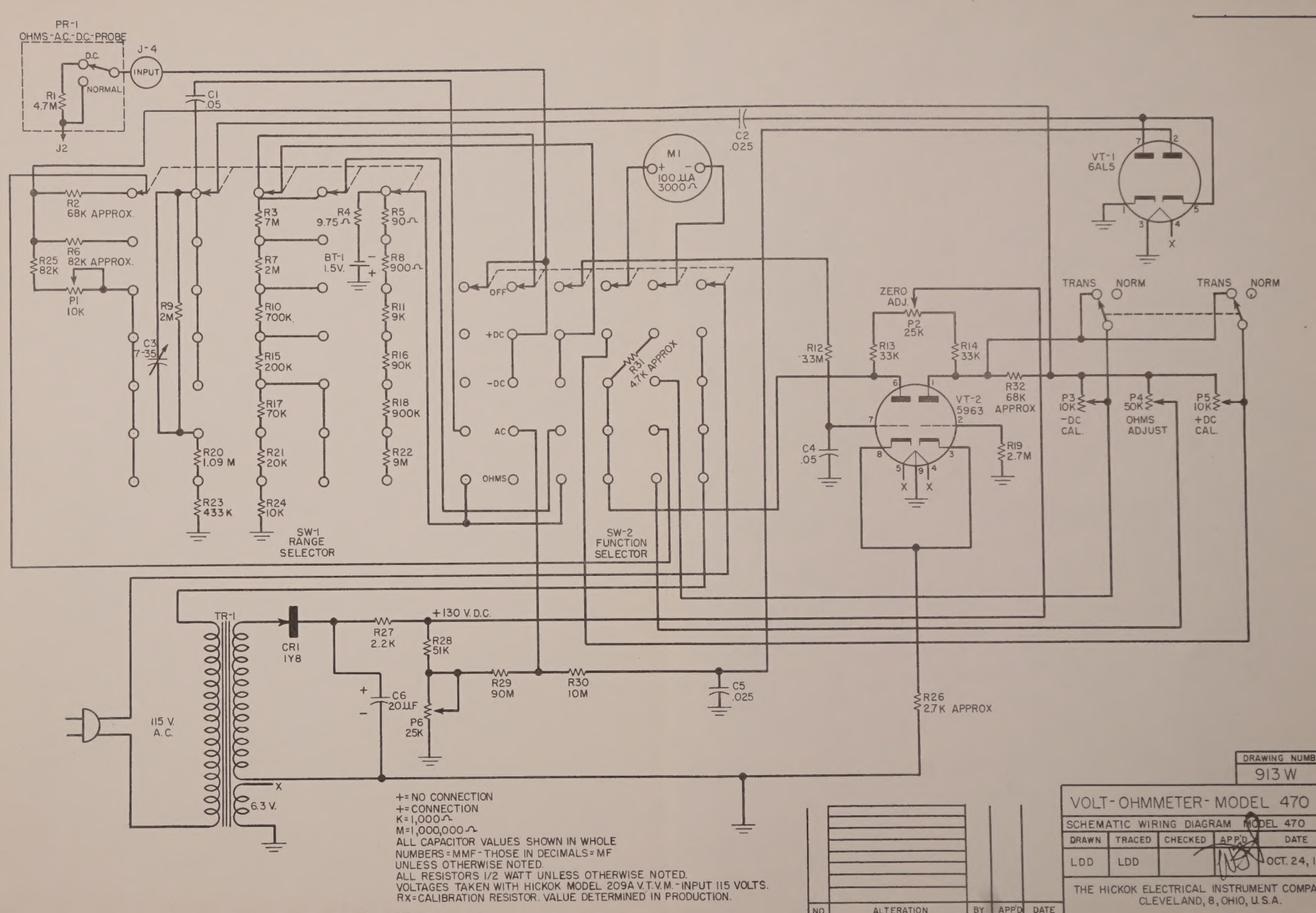
NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

Hickok Code No.	Name and Description	Symbol Ref.
18537-44	Resistor, fixed: film, 9000 Ω, 1%, ½ watt, Electra DC ½A.	R11
18415-332	Resistor, fixed: composition, 3.3 megohms, 10%, ½ watt, Allen Bradley type EB	R12
18413-331	Resistor, fixed: composition, 33,000 Ω, 5%, ½ watt, Allen Bradley type EB	R13-14
18537-46	Resistor, fixed: film, 200,000 Ω, 1%, ½ watt, Electra DC ½A.	R15
18537-43	Resistor, fixed: film, 90,000 Ω, 1%, ½ watt, Electra DC ½A	R16
18537-49	Resistor, fixed: film, 70,000 Ω, 1%, ½ watt, Electra DC ½A.	R17
18537-53	Resistor, fixed: film, 900,000 Ω, 1%, ½ watt, Electra DC ½A.	R18
18415-272	Resistor, fixed: composition, 2.7 megohms, 10%, ½ watt, Allen Bradley type EB	R19
18537-113	Resistor, fixed: film, 1.09 megohms, 1% ½ watt, Electra DC ½A.	R20
18537-48	Resistor, fixed: film, 20,000 Ω, 1%, ½ watt, Electra DC ½A.	R21
18539-6	Resistor, fixed: film, 9 megohms, 1%, 1 watt, Electra DC 1	R22
18537-111	Resistor, fixed: film, 433K ohms, 1%, ½ watt, Electra DC ½A.	R23
18537-47	Resistor, fixed: film, 10,000 Ω, 1%, ½ watt, Electra DC ½A.	R24
18413-822	Resistor, fixed: composition, 82,000 Ω, 10%, ½ watt, Allen Bradley type EB	R25
	Resistor, fixed: approx. 2.7K, to be determined in production	R26
18412-222	Resistor, fixed: composition, 2200 Ω, 10%, ½ watt, Allen Bradley type EB	R27
18413-513	Resistor, fixed: composition, 51,000 Ω, 10%, ½ watt, Allen Bradley type EB	R28
18575-98	Resistor, fixed: deposited film, 90 megohms, 2%, 2 watt, Aerovox Hi Q	R29
18416-101	Resistor, fixed: composition, 10 megohms, 5%, ½ watt, Allen Bradley type EB	R30
	Resistor, 4.7K approximately, to be determined in production	R31
	Resistor, 68K approximately, to be determined in production	R32

PARTS LIST FOR MODEL 470

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

Hickok Code No.	Name and Description	Symbol Ref.
19912-370	Switch: rotary, 5 section, 7 position, Range Selector, Oak Type G	SW1
19912-369	Switch: rotary, 3 section, 5 position, Function Selector, Oak Type G	SW2
19911-7	Switch: snap, DPDT	SW3
20800-185	Transformer: power	TR1
20875-51	Tube: 6AL5	VT1
20875-107	Tube: 5963	VT2
	Battery: unit cell, Size C, 1.5V, National Carbon #935 or equal	BT1



+= NO CONNECTION
+= CONNECTION
K=1,000Ω
M=1,000,000Ω
ALL CAPACITOR VALUES SHOWN IN WHOLE NUMBERS=MMF-THOSE IN DECIMALS=MF UNLESS OTHERWISE NOTED.
ALL RESISTORS 1/2 WATT UNLESS OTHERWISE NOTED.
VOLTAGES TAKEN WITH HICKOK MODEL 209A V.T.V.M.-INPUT 115 VOLTS.
RX=CALIBRATION RESISTOR. VALUE DETERMINED IN PRODUCTION.

NO	ALTERATION	BY	APP'D	DATE

DRAWING NUMB
913 W

VOLT-OHMMETER-MODEL 470

SCHEMATIC WIRING DIAGRAM MODEL 470

DRAWN	TRACED	CHECKED	APP'D	DATE
LDD	LDD			OCT. 24,

THE HICKOK ELECTRICAL INSTRUMENT COMPA
CLEVELAND, 8, OHIO, U.S.A.